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13. ABSTRACT (Maximum 200 words) <p>AASERT funds supported the M.S. research for Mr. David Miller. He completed a study of diagnostic cloud schemes to examine the variability of cloud fractions in monsoon systems. AT T213 global model resolution, he simulated and studied the middle tropospheric cyclone (MTC) of the Asian monsoon. Cloud radiation is a key factor in the thermodynamic control of the local east-west circulation. He showed the coalescence of small vorticity elements; these coalesce to form a 'parent' large scale mid-tropospheric cyclone. The study of the thermodynamics of this system constituted his thesis research. He compared various methods for determining precipitation rates associated with the MTC, and also showed that most of precipitation was due to convective processes rather than stable processes which are characterized by the general monsoon pattern.</p> <p>Following Mr. Miller's completion of the M.S. degree in May, 1996, AASERT funds have supported the research of Mr. Brian Mackey who is studying the formation of a Pacific Typhoon (Winnie, 1997).</p>				
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Prediction of Cloud Cover with a Global Model

Dr. T.N. Krishnamurti  
 Department of Meteorology  
 Florida State University  
 Tallahassee, FL 32306-4520  
 (850) 644-2210  
 e-mail: tnk@met.fsu.edu

These funds have supported two students: 1) Mr. David Miller during the period 6/1/94 - 5/31/96 and 2) Mr. Brian Mackey during the period 6/1/96 - 5/31/97.

Research Summary

## 1) David Miller

Mr. Miller's research included the study of mid-tropospheric cyclones (MTC's). The MTC events that occurred in August, 1992 and September, 1990 were shown to be similar in many aspects to other MTC events that were studied by Krishnamurti and Hawkins (1970), Mak (1975) and Carr (1977). The vorticity structures showed a center of circulation near 600 mb with a cold core anomaly below the center and a warm core above.

Similar results in the MTC's characteristics were reproduced using the FSU Global Spectral Model. Although the model tended to move the system to the west, the structure of the MTC remained consistent with the observed data.

Analysis of MTCs showed a pattern of movement of anomalous vorticity centers. These anomalous centers were shown to be governed by a vertical circulation that developed near the center of the MTC. These centers showed a consistent pattern of movement and development within this vertical circulation that was reproduced using the FSU Global Spectral Model.

Prior to the formation of the MTC, these centers of anomalous vorticity began to coalesce and combine into large centers with multiple points of origin. These centers would continue to rotate around the vertical circulation. The position of this vertical circulation was such that the anomalous vorticity centers would travel vertically through the eventual position of the MTC. The attached figure, where vertical streamlines are superimposed on the vertical cross-section of anomalous vorticity, shows such propagation and coalescence of anomalous vorticity by the vertical circulation between 00 UTC of August 15 and 12 UTC of August 16, 1992. It was suggested that this vertical circulation of anomalous vorticity centers might be a possible forcing mechanism for the MTC.

In order to show that the vertical movement of these anomalous vorticity centers was significant to the vorticity tendency of the MTC, a vorticity budget was performed using the

model results. These results showed that the vertical advection of vorticity was one of the largest positive contributing terms in the budget.

Analysis indicated an area of potential vorticity advection (PVA) near the center of the MTC. It is this area of PVA that is most likely responsible for the formation of the heavy rainfall associated with the MTC. The largest contributor to the PVA was due to the vertical advection of vorticity. There appeared to be a correlation between the movement of the anomalous vorticity centers and the production of heavy convective rainfall along the west coast of India.

It was shown that this vertical circulation of anomalous vorticity is responsible in part for the maintenance of the MTC and heavy rainfall.

A thermal budget of model results was performed. The results showed that most of the individual terms of thermal tendency had a positive correlation to the total thermal tendency. The deterioration of the MTC was observed through the trends found in the total thermal tendency. Throughout the period of study, the total tendency of the warm core was in a steady decline. Likewise, the total tendency of the cold core was in a steady incline. Therefore, the amplitude of both the cold and warm cores became smaller as the system deteriorated.

Rainfall rates were also determined for the MTC. Most of the precipitation was found to be due to convective processes in contrast to large scale for general monsoon rainfall.

Results of his study are included in Mr. Miller's Master's Thesis entitled "Vertical Sweeping of Anomalous Vorticity as a Trigger Mechanism for the Mid-Tropospheric Cyclone. The Master of Science degree was awarded to Mr. Miller in May, 1996.

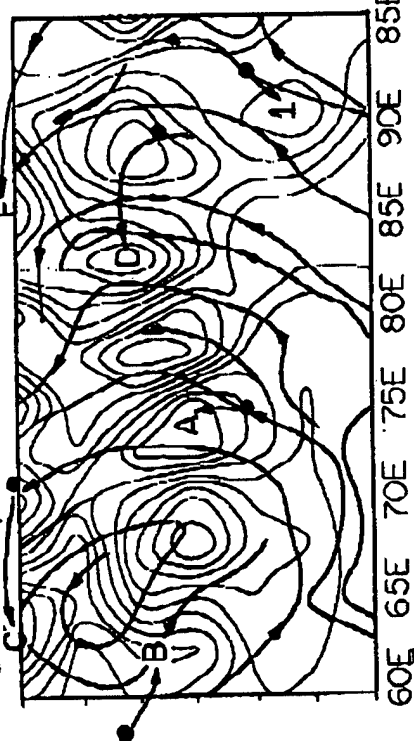
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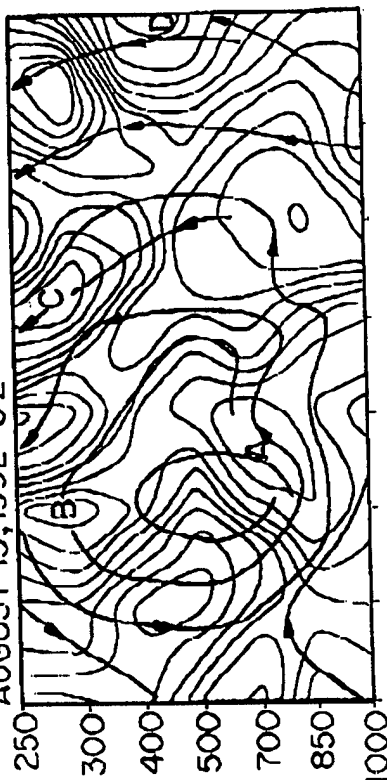
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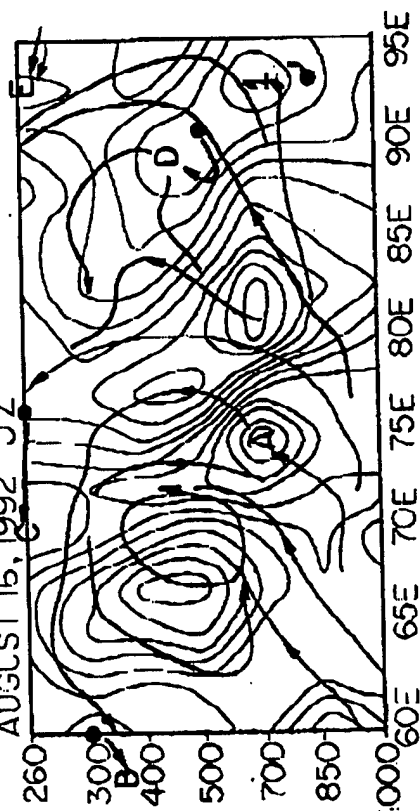
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## 2) Brian Mackey

Mr. Mackey has followed up on the work of David Miller on the prediction of tropical storms using very high resolution global models. A recent typhoon, Winnie of August 1997, provided a unique challenge in the modeling over two regions: This devastating typhoon caused much damage to property and life over Taiwan and China during a four day period from heavy winds, landslides and floods. Winnie was a straight moving typhoon until it reached Taiwan. It made landfall over the northern part of the island and moved directly north of Taipei causing significant damage. It was a category 3 storm. This storm weakened somewhat as it moved inland and re-intensified in the straits prior to its landfall over China. The modeling effort, for the MS degree of Mr. Brian Mackey, includes the following.

- a) Physical initialization at the resolution T170. This incorporates the rain rates from satellite measures (SSM/I and OLR) in the initial state.
- b) Ensemble forecasts for a four day duration, that include the prediction of the following features:
  - i) Landfall over Taipei (ensemble averaged tracks)
  - ii) Ensemble averaged rainfall forecast over Taiwan
  - iii) Landfall over China (ensemble averaged tracks, and
  - iv) Rainfall and flooding as seen from ensemble averaged predicted precipitation.

In addition, these forecasts provide fields of clouds, pressure, winds and surface fluxes from the ensemble averages.